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Physical and Bromatological Evaluation of Stockpiled Marandu Grass and Urochloa Hybrids

Avaliação Físico-Química e Bromatológica de Capim-Marandu e Híbridos de Urochloa Sob Diferimento


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Jhonatan Gonçalves Silva: Universidade Federal de Uberlândia, Faculdade de Medicina Veterinária e Zootecnia. MG, Brazil. E-mail: jhonatang.silva@hotmail.com 


Brenda Nunes de Oliveira: Zootecnista. MG, Brazil.

Yuri Cleber Souza Silva: Zootecnista. MG, Brazil. 

Romario Celso Oliveira Moura Junior: Universidade Federal de Uberlândia, Faculdade de Medicina Veterinária e Zootecnia. MG, Brazil. 

Alexandre Bicalho do Amaral: Universidade Federal de Uberlândia, Faculdade de Medicina Veterinária e Zootecnia. MG, Brazil. 

Simone Pedro da Silva: Universidade Federal de Uberlândia, Faculdade de Medicina Veterinária e Zootecnia. MG, Brazil. 

Natascha Almeida Marques da Silva: Universidade Federal de Uberlândia, Faculdade de Medicina Veterinária e Zootecnia. MG, Brazil. 

Abstract

Pasture stockpiling is an important strategy to reduce forage shortages during the dry season in tropical livestock systems. However, information regarding the physical and bromatological characteristics of recently released Urochloa hybrids under stockpiling management remains limited. Therefore, this study evaluated the grinding resistance and bromatological characteristics of tillers from Urochloa brizantha cv. Marandu and three Urochloa hybrids (Convert HD 364, Mavuno, and Ipyporã) managed under stockpiling conditions. The experiment was conducted in a completely randomized design with four forage grasses and four replications. The stockpiling period lasted from March to June 2021. Samples of forage mass and vegetative and reproductive tillers were collected for bromatological analyses and grinding resistance evaluation. Data were analyzed using Tukey's

test at a 10% significance level. Ipyporã grass showed lower neutral detergent fiber (NDF) concentrations and a lower proportion of live stem, associated with a greater proportion of live leaf tissues, indicating potentially greater forage digestibility. Mavuno grass presented lower grinding resistance in reproductive tillers, suggesting greater particle fragility and possible advantages related to ruminal passage dynamics and forage intake. The results indicate that Ipyporã and Mavuno grasses exhibit favorable nutritional and physical characteristics under stockpiling management, highlighting their potential use in tropical pasture-based systems.

Keywords: Deferred Grazing. Forage Quality. Grinding Resistance. Neutral Tetergent Fiber. Tropical Grasses.

Resumo

O diferimento de pastagens é uma importante estratégia para reduzir a escassez de forragem durante o período seco em sistemas tropicais de produção animal. Entretanto, ainda são limitadas as informações sobre as características físicas e bromatológicas de híbridos recentemente lançados do gênero *Urochloa* sob manejo de diferimento. Objetivou-se avaliar a resistência à moagem e as características bromatológicas de perfilhos de *Urochloa brizantha* cv. Marandu e de três híbridos de *Urochloa* (Convert HD 364, Mavuno e Ipyporã) manejados sob diferimento. O experimento foi conduzido em delineamento inteiramente casualizado, com quatro gramíneas forrageiras e quatro repetições. O período de diferimento ocorreu entre março e junho de 2021. Foram coletadas amostras de massa de forragem e de perfilhos vegetativos e reprodutivos para análises bromatológicas e avaliação da resistência à moagem. Os dados foram analisados pelo teste de Tukey ao nível de 10% de significância. O capim Ipyporã apresentou menores concentrações de fibra em detergente neutro (FDN) e menor proporção de colmo vivo, associadas à maior proporção de folhas vivas, indicando potencialmente maior digestibilidade da forragem. O capim Mavuno apresentou menor resistência à moagem nos perfilhos reprodutivos, sugerindo maior fragilidade das partículas e possíveis vantagens relacionadas à dinâmica de passagem ruminal e ao consumo de forragem. Os resultados demonstram que os capins Ipyporã e Mavuno apresentam características físicas e nutricionais favoráveis sob manejo de diferimento, destacando seu potencial para utilização em sistemas tropicais de produção a pasto.

Palavras-chave: Pasto Diferido. Qualidade da Forragem. Resistência à Moagem. Fibra em Detergente Neutro. Gramíneas Tropicais.

1 Introduction

Brazil has the largest commercial cattle herd in the world, with approximately 230 million head, and about 88% of the beef produced in the country originates from animals raised exclusively on pasture (PPM, 2020). Therefore, pastures play a fundamental role in the development of Brazilian livestock production, and technologies applied to forage plant breeding, as well as pasture stockpiling management, are important tools for improving productivity indexes in Brazilian cattle systems.

The well-defined climatic seasons in Brazil directly affect forage production in tropical pastures, since pasture growth is closely associated with rainfall, photoperiod, temperature, and other climatic factors. Consequently, forage production is high during the rainy season and low during the dry season, resulting in marked seasonal forage availability. One strategy to minimize the negative

effects of forage production seasonality is pasture stockpiling.

Pasture stockpiling consists of selecting specific pasture areas and excluding them from grazing, generally at the end of summer and/or during autumn in the Southeast and Midwest regions of Brazil. This strategy allows forage to accumulate for grazing during periods of scarcity, thereby reducing the effects of seasonal forage production (Afonso *et al.*, 2018).

For adequate stockpiling management, the selection of appropriate forage grasses is essential, as it directly affects forage production and quality. In this context, grasses with short stature, thin stems, and a high leaf-to-stem ratio are considered desirable (Santos; Martuscello, 2022). Species of the genus *Urochloa*, such as Marandu grass, are among the most widely used tropical forages in Brazil, including under stockpiling management. Recently released *Urochloa* hybrids, such as Convert HD 364, Ipyporã, and Mavuno, may also represent promising alternatives for stockpiling due to their morphological characteristics. However, further studies are required to better understand the nutritional value and physical characteristics of these forages under stockpiling conditions (Santos; Martuscello, 2022).

Studies evaluating the nutritional characteristics of these new cultivars are still limited, especially under stockpiling management. Therefore, investigations addressing their morphological, physical, and chemical-bromatological characteristics are important because these factors directly influence forage intake and may contribute to improvements in pasture management strategies.

Studies characterizing pastures in terms of forage chemical composition and physical properties are relevant for forage evaluation because they assist in defining supplementation strategies for different seasons of the year and animal categories. Furthermore, the assessment of forage nutritive value contributes to identifying factors that may restrict nutrient intake and, consequently, animal production (Detmann *et al.*, 2021).

Physical characteristics, such as resistance to particle breakdown during mastication and rumination, can influence microbial digestion and nutrient utilization by animals. Some forage species may present high concentrations of certain nutrients but also exhibit high resistance to particle fragmentation, which may impair microbial degradation and limit forage intake by increasing ruminal fill (Oliveira *et al.*, 2017).

In recent years, three *Urochloa* hybrids (Convert HD 364, Mavuno, and Ipyporã) have been introduced into the market and widely promoted among livestock producers. However, detailed information regarding their physical and nutritive characteristics under stockpiling management is still scarce. Therefore, this study aimed to evaluate differences in the chemical-bromatological and

physical characteristics of stockpiled Marandu grass and Urochloa hybrids (Convert HD 364, Ipyporã, and Mavuno).

2 Material and Methods

The study was conducted from December 2021 to March 2022 at the Capim Branco Experimental Farm and at the Animal Bromatology and Nutrition Laboratory (LABAN) of the School of Veterinary Medicine, Federal University of Uberlândia (UFU), located in Uberlândia, Minas Gerais, Brazil. The experimental area consisted of 16 experimental plots (experimental units), each measuring 16 m².

The experiment was carried out in a completely randomized design with four treatments and four replications, totaling 16 experimental plots. The experimental plots had standardized dimensions and were managed under the same edaphoclimatic and management conditions throughout the experimental period in order to minimize possible sources of experimental variability. The treatments consisted of four forage grasses: Urochloa brizantha cv. Marandu (Marandu grass) and three Urochloa hybrids (Convert HD 364, Mavuno, and Ipyporã).

Starting in December 2020, all plants present in the plots were maintained at 30 cm height through weekly cuts using pruning shears in order to simulate continuous stocking conditions. The cuts were performed weekly following standardized height and management criteria in all experimental plots, aiming to standardize pasture structure before the beginning of the stockpiling period. After cutting, excess forage material remaining on the plants was removed to avoid inhibiting regrowth. This maintenance period at 30 cm height ended in early March 2021, when the grasses were stockpiled.

The stockpiling period began on March 15, 2021, and ended on June 15, 2021, totaling 90 days. At the end of the stockpiling period, 50 reproductive tillers and 50 vegetative tillers were randomly collected at ground level from each plot. Sampling procedures were standardized across all experimental units using the same criteria for collection, processing, and drying of samples in order to ensure greater analytical consistency and reproducibility of the results. Forage mass samples were also collected. For forage mass evaluation, all tillers contained within a 0.25 m² quadrat were harvested at ground level. Subsequently, the samples were weighed and dried in a forced-air oven at 65 °C for 72 h.

For grinding resistance analysis, vegetative and reproductive tiller samples were ground in a Wiley mill using a 5-mm screen. Subsequently, 20 g of this material were reground in a Wiley mill

fitted with a 1-mm screen for 25 seconds. The ground material (1 mm) and the residual unground material from these subsamples were weighed using a semi-analytical balance. Grinding resistance was quantified based on the proportion of material retained when reducing particle size from 5 to 1 mm, according to Hughes *et al.* (1998).

After drying, forage mass, vegetative tiller, and reproductive tiller samples were ground to pass through a 1-mm screen and analyzed at the Animal Bromatology and Nutrition Laboratory (LABAN) from January to June 2022. Analyses included dry matter (DM), crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF), according to the methods proposed by INCT-CA (Detmann *et al.*, 2021).

Potentially digestible neutral detergent fiber (pdNDF) was estimated according to the equation: $\text{pdNDF} = \% \text{NDF} - \% \text{iNDF}$. Potentially digestible dry matter (pdDM) was estimated using the equation: $\text{pdDM} = [0.98 \times (100 - \text{NDF}) + (\text{NDF} - \text{iNDF})]$ (Paulino *et al.*, 2008). The concentration of indigestible neutral detergent fiber (iNDF) was determined by ruminal incubation in TNT bags in fistulated sheep for 240 h (Valente *et al.*, 2011). Ruminal incubation was performed using previously fistulated sheep managed according to the institutional animal welfare protocols adopted by the institution.

For each evaluated characteristic, analysis of variance (ANOVA) was performed using a completely randomized design in a split-plot arrangement. The plots consisted of the four forage grasses, while the subplots consisted of tiller types (vegetative and reproductive). Subsequently, treatment means were compared using Tukey's test at a 10% significance level. A significance level of 10% was adopted considering the high biological variability commonly observed in field experiments with tropical forages, as well as the exploratory nature of the study involving *Urochloa* hybrids that are still poorly investigated regarding their physical and bromatological characteristics under stockpiling management.

3 Results and Discussion

Lower NDF and iNDF concentrations were observed in the forage mass samples of Ipyporã grass ($P < 0.10$; Table 1). This difference may be associated with the morphological composition of this forage, since Ipyporã grass presented a lower proportion of live stem and a greater proportion of live leaf in vegetative tillers ($P < 0.10$; Table 3). According to Santos *et al.* (2010), who evaluated the chemical composition of different morphological components of stockpiled *Urochloa decumbens* cv. Basilisk fertilized with nitrogen, live stem was the component with the highest NDF concentration when compared with live and dead leaf tissues.

Table 1 - Chemical-bromatological composition of forage mass, vegetative tillers, and reproductive tillers of Marandu, Mavuno, Mulato II, and Ipyporã grasses

Forage Mass							
	DM	CP	NDF	ADF	iNDF	pdNDF	pdDM
Marandu	90,36a	3,63a	73,59a	36,63a	22,98a	43,98a	76,35b
Mavuno	92,18a	3,82a	71,27ab	35,07a	20,83ab	44,86a	78,48ab
Mulato	91,96a	3,92a	71,63ab	34,65a	19,37b	46,76a	80,19a
Ipyporã	92,02a	4,06a	69,02b	34,20a	19,13b	44,14a	79,89ab
Vegetative Tiller							
	MS	PB	FDN	FDA	FDNi	FDNpd	pdDM
Marandu	90,72a	5,13a	70,25a	32,99a	17,17a	44,72a	80,26a
Mavuno	91,43a	5,01a	68,18a	32,11a	16,18a	16,18a	80,06a
Mulato	91,88a	5,64a	66,89ab	32,48a	15,65a	15,73a	83,57a
Ipyporã	91,17a	5,39a	63,52b	30,26a	15,73a	15,65a	83,42a
Reproductive Tiller							
	DM	CP	NDF	ADF	iNDF	pdNDF	pdDM
Marandu	92,55a	4,18a	68,48a	32,53a	22,83a	40,54a	76,44a
Mavuno	92,20a	4,15a	68,26a	32,97a	19,86a	43,08a	79,39a
Mulato	92,37a	3,62a	68,18a	31,49a	22,12a	40,86a	77,14a
Ipyporã	92,94a	4,41a	65,79a	31,32a	19,50a	41,66a	79,73a

Legend: DM: dry matter, CP: crude protein, NDF: fiber detergent neutral, ADF: fiber detergent acid, iNDF: fiber detergent neutral indigestible, pdNDF: Neutral detergent fiber, potentially digestible, pdDM: dry matter potentially digestible; Means within a row followed by different letters differ significantly according to Tukey's test ($P < 0.10$).

Source: research data

In the vegetative tiller samples, Ipyporã grass showed lower NDF concentrations ($P < 0.10$; Table 1). When iNDF content was expressed relative to total NDF concentration, Ipyporã and Mulato II grasses numerically presented the lowest iNDF concentrations in forage mass samples, whereas Ipyporã and Mavuno grasses showed the lowest iNDF concentrations in vegetative tillers (Table 2).

Table 2 - iNDF and pdNDF concentrations expressed relative to NDF content in forage mass, vegetative tillers, and reproductive tillers of Marandu, Mavuno, Ipyporã, and Mulato II grasses

Forage Mass		
	iNDF (%NDF)	pdNDF(%NDF)
Marandu	34.29	39.30
Mavuno	31.70	39.57
Ipyporã	29.09	42.54
Mulato II	30.53	38.49
Vegetative Tiller		
	iNDF (%NDF)	pdNDF(%NDF)
Marandu	29.81	40.44
Mavuno	25.93	42.25
Ipyporã	25.48	41.41
Mulato II	27.27	36.25
Reproductive Tiller		
	iNDF (%NDF)	pdNDF(%NDF)
Marandu	36.04	32.44
Mavuno	31,63	36.63
Ipyporã	35.16	33.02
Mulato II	31.92	33.88

Legend: NDF: fiber detergent neutral, ADF: fiber detergent acid, iNDF: fiber detergent neutral indigestible, pdNDF: Neutral detergent fiber, potentially digestible, pdDM: dry matter potentially digestible; Means within a row followed by different letters differ significantly according to Tukey's test ($P < 0.10$).

Source: research data.

The lower NDF concentration observed in vegetative tillers of Ipyporã grass may be associated with its greater proportion of live leaves and lower proportion of live stems ($P < 0.10$; Table 3). In addition, the numerically lower iNDF concentrations relative to total NDF may indicate fiber with superior nutritional quality. Furthermore, this forage may present distinct genetic characteristics associated with a greater proportion of more digestible plant tissues.

Table 3 - Morphological composition of forage mass, vegetative tillers, and reproductive tillers of Marandu, Mavuno, Mulato II, and Ipyporã grasses

Forage Mass			
	Live leaf (%)	Dead leaf (%)	Live stem (%)
Marandu	14,72a	25,84a	32,58b
Mavuno	13,80a	24,92a	34,05ab
Mulato II	15,67a	24,73a	35,23ab
Ipyporã	13,48a	27,25a	39,64a
Vegetative Tiller			
	Live leaf (%)	Dead leaf (%)	Live stem (%)
Marandu	43,43b	18,80a	37,76a
Mavuno	45,28b	13,44a	41,28a
Mulato II	45,84b	19,48a	34,68a
Ipyporã	60,46a	11,98a	27,56b
Reproductive Tiller			
	Live leaf (%)	Dead leaf (%)	Live stem (%)
Marandu	11,25b	38,64a	39.15b
Mavuno	14,66a	29,41b	46.13a
Mulato II	10,48b	41,82a	35.88b
Ipyporã	10,85b	40,29a	38.92b

Means within a row followed by different letters differ significantly according to Tukey's test ($P < 0.10$).

Source: research data

Leaf anatomy can influence forage nutritive value and consequently animal performance, since plant tissues differ in ruminal digestibility according to cell wall type, tissue location, and distribution within the leaf structure. Some tissues, such as mesophyll and phloem cells, do not possess secondary cell walls and therefore are not susceptible to lignification, resulting in rapid digestion (Basso; Barbero, 2015). In this context, further studies are necessary to evaluate the anatomical composition of tissues present in Ipyporã grass and to confirm the occurrence of more digestible plant fractions in this forage.

No differences were observed in the chemical composition of reproductive tillers among the grasses evaluated ($P > 0.10$; Table 1). This result may be explained by the advanced developmental stage of reproductive tillers, which are close to the end of their life cycle. At this stage, differences among forage grasses tend to become less evident.

Tillers at more advanced developmental stages, such as reproductive tillers, exhibit greater morphological differentiation and are therefore less susceptible to variations caused by growth-stimulating factors and genetic differences among forage grasses (Santos *et al.*, 2010). In other words, differences among genetic materials are easier to identify during early growth stages, whereas these

differences become less pronounced as plant development advances.

On the other hand, differences among grasses were observed for grinding resistance in reproductive tillers, which are structurally more rigid than vegetative tillers ($P < 0.10$; Table 4). Mavuno grass exhibited lower grinding resistance ($P = 0.08$), which may be associated with the morphological composition of this forage, characterized by a greater proportion of live leaves and a lower proportion of dead leaves in vegetative tillers. Live leaves are considered plant components with superior nutritive value. Santos *et al.* (2010), when evaluating the chemical composition of different morphological plant components, reported higher crude protein concentrations and lower NDF, ADF, and lignin concentrations in live leaf tissues.

Table 4 - Grinding resistance of reproductive tillers of Marandu, Mavuno, Ipyporã, and Mulato II grasses

	Grinding Resistance
Mulato	0,517a
Marandu	0,451ab
Ypiporã	0,463ab
Mavuno	0,450b

Means within a row followed by different letters differ significantly according to Tukey's test ($P < 0.10$).

Source: research data.

Despite the greater proportion of live stem observed in vegetative tillers of Mavuno grass ($P < 0.10$; Table 3), its lower grinding resistance may be associated with the presence of thinner stems in this forage. According to Herrero *et al.* (2001), mechanical mastication, rumination, and microbial digestion influence both the rate of feed particle breakdown and the elimination rate of indigestible material from the rumen. Therefore, forages with lower resistance to fragmentation may favor greater feed intake by increasing passage rate and promoting faster ruminal emptying, thereby allowing animals to consume larger amounts of forage.

However, further studies are necessary to confirm whether the lower grinding resistance observed in Mavuno grass may effectively contribute to increased forage intake and reduced ruminal fill in grazing animals.

4 Conclusion

Ipyporã grass presented a lower proportion of live stem, a greater proportion of live leaf, and lower neutral detergent fiber (NDF) concentrations, indicating a potentially greater presence of more digestible tissues in this forage.

Mavuno grass exhibited lower grinding resistance, suggesting physical characteristics potentially favorable to ruminal degradation and passage dynamics. However, further studies evaluating animal intake and performance are necessary to confirm its potential nutritional benefits

in pasture-based production systems.

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